# LIME KILN OPTIMIZATION THROUGH LEAN SIX SIGMA

A comprehensive report on the processes involved while optimizing large equipment

## Lime History

Lime (also known as calcium oxide), has been used around the world for thousands of years. The first recorded use was in mortar production in Turkey 7,000 to 14,000 years ago. The uses and production methods of lime have evolved over time to keep up with demand and technology.

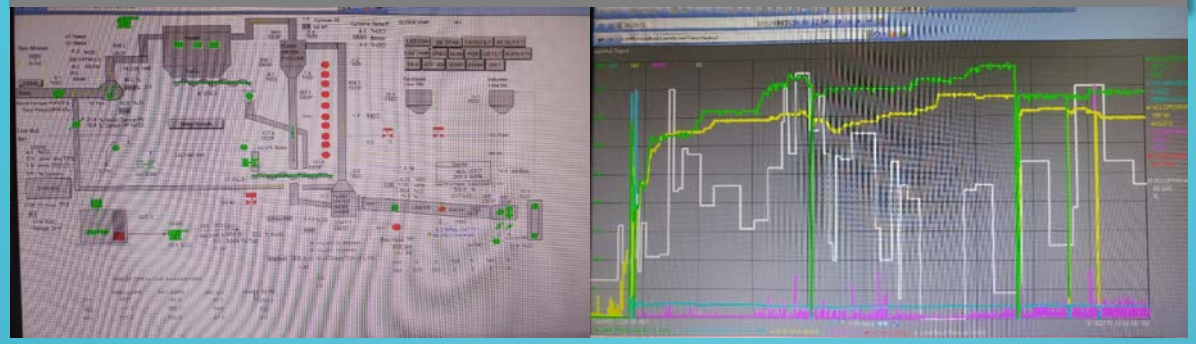
## Lean Six Sigma

Lean Six Sigma (LSS) is an analytical problem solving and optimization system that takes advantage of the three sigmas (three standard deviations) on either side of the "normal curve", and eliminating wasted, or "non-value added" time. A LSS project consists of a seven step, chronological process known as PDMAICS.

- (P) Pre-Define
- (D) Define
- (M) Measure
- (A) Analyze
- (I) Improve
- (C) Control
- (S) Sustain

Each step contains different strategies and tools to help the project along.

## Pi (Plant Information Management Systems)

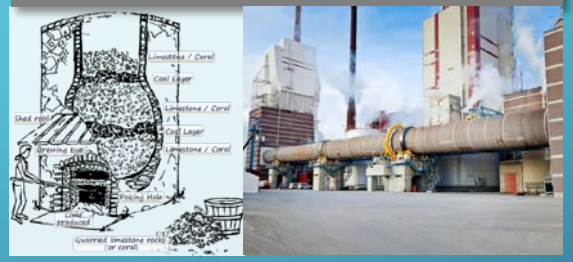


## Kiln Chemistry

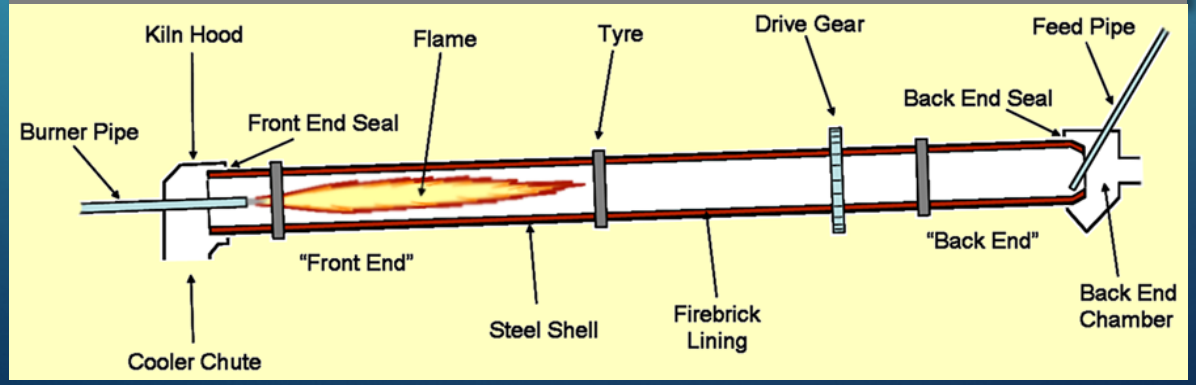
Lime (CaO) is produced by heating limestone ($CaCO_3$) to temperatures between 1,000 and 2,000 °F.

$$CaCO_3(s) + Heat \rightarrow CaO(s) + CO_2(g)$$

## Historic and Modern Kilns



## Modern Kiln Schematic




## Sappi Cloquet/Project Justification

Sappi Cloquet is a dissolving pulp and coated paper mill located in Minnesota. The pulp mill follows a Kraft-like process to and therefore needs lime. The lime kiln needed to increase production and uptime. These shortcomings cost millions of dollars annually.


## Savings & Costs

| | |
|---|---|
| Uptime | $500,000 |
| Permit Restrictions | $200,000 |
| Increased Throughput | $1,400,000 |
| Landfilling | $200,000 |
| Fuel Gas | $100,000 |
| Total Savings | $2,200,000 |

Full report available upon request